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Utilization of Lightweight Materials Made From Coal Gasification Slags

Quarterly Report
September 1 - November 30, 1997

Work Performed Under Contract No.: DE-FC21-94MC30056

For
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Office of Fossil Energy
Federal Energy Technology Center
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1.0 PROJECT OBJECTIVES, SCOPE AND DESCRIPTION OF TASKS

1.1 Introduction

The integrated-gasification combined-cycle (IGCC) process is an emerging technology that utilizes coal for power generation and production of chemical feedstocks. However, the process generates large amounts of solid waste, consisting of vitrified ash (slag) and some unconverted carbon. In previous projects, Praxis investigated the utilization of "as-generated" slags for a wide variety of applications in road construction, cement and concrete production, agricultural applications, and as a landfill material. From these studies, we found that it would be extremely difficult for "as-generated" slag to find large-scale acceptance in the marketplace even at no cost because the materials it could replace were abundantly available at very low cost. It was further determined that the unconverted carbon, or char, in the slag is detrimental to its utilization as sand or fine aggregate. It became apparent that a more promising approach would be to develop a variety of value-added products from slag that meet specific industry requirements. This approach was made feasible by the discovery that slag undergoes expansion and forms a lightweight material when subjected to controlled heating in a kiln at temperatures between 1400 and 1700°F. These results confirmed the potential for using expanded slag as a substitute for conventional lightweight aggregates (LWA). The technology to produce lightweight and ultra-lightweight aggregates (ULWA) from slag was subsequently developed by Praxis with funding from the Electric Power Research Institute (EPRI), Illinois Clean Coal Institute (ICCI), and internal resources.

The major objectives of the subject project are to demonstrate the technical and economic viability of commercial production of LWA and ULWA from slag and to test the suitability of these aggregates for various applications. The project goals are to be accomplished in two phases: Phase I, comprising the production of LWA and ULWA from slag at the large pilot scale, and Phase II, which involves commercial evaluation of these aggregates in a number of applications.

Primary funding for the project is provided by DOE's Federal Energy Technology Center (FETC) at Morgantown, with significant cost sharing by Electric Power Research Institute (EPRI) and Illinois Clean Coal Institute (ICCI).

1.2 Scope of Work

The Phase I scope consisted of collecting a 20-ton sample of slag (primary slag), processing it for char removal, and pyroprocessing it to produce expanded slag aggregates of various size gradations and unit weights, ranging from 12 to 50 lb/ft^3. In Phase II, the expanded slag aggregates are being tested for their suitability in manufacturing precast concrete products (e.g., masonry blocks and roof tiles) and insulating concrete, first at the laboratory scale and subsequently in commercial manufacturing plants. These products will be evaluated using ASTM and industry test methods. Technical data generated during production and testing of the products will be used to assess the overall technical viability of expanded slag production. Relevant cost data for physical and pyroprocessing of slag to produce expanded slag aggregates will be gathered for comparison with (i) the management and disposal costs for slag or similar wastes and (ii) production costs for conventional materials which the slag aggregates would replace. In addition, a market assessment will be made to evaluate the economic viability of these utilization technologies.

1.3 Phase I Task Description

A summary of the tasks performed in Phase I is given below:

Task 1.1 **Laboratory and Economic Analysis Plan Development**: Development of a detailed work plan for Phase I and an outline of the Phase II work.

Task 1.2 **Production of Lightweight Aggregates from Slag**: This task covered selection and procurement of project slag samples, slag preparation including screening and char removal, and slag expansion in a direct-fired kiln and fluid bed expander. The char recovered from the slag preparation operation was evaluated for use as a kiln fuel and gasifier feed. Environmental data for slag-based lightweight aggregate (SLA) production was collected.

Task 1.3 **Data Analysis of Slag Preparation and Expansion**: Analysis and interpretation of project data, including development of material and energy balances for slag processing and product evaluation.

Task 1.4 **Economic Analysis of Expanded Slag Production**: Economic analysis of the utilization of expanded slag was conducted by determining production costs for slag-based LWAs and ULWAs. Expanded slag production costs were compared with the market value of similar products both with and without taking into account the avoided costs of disposal and with the costs of management of slag as a solid waste.

Task 1.5 **Topical and Other Reports**: Preparation topical, financial status, and technical progress reports in accordance with the Statement of Work.

1.4 Phase II Task Description

A summary of the tasks to be performed in Phase II is given below.

Task 2.1 **Test Plan for Applications of Expanded Slags (Field Studies)**: This task involves the development of selection criteria and a field test plan for applications of expanded slag. This plan will serve as a guide in the selection and implementation of field demonstrations for the most promising expanded slag utilization applications. Field applications will be selected on the basis of laboratory results, the marketability of the products, and the suitability of the project slags for producing them. The following applications are under consideration for testing:

- Lightweight concrete blocks made from 50 lb/ft^3 SLA
- Lightweight roof tiles made from 40 lb/ft^3 SLA
- Loose fill insulation made from 16 lb/ft^3 SLA
- Lightweight insulating concrete made from 16 lb/ft^3 SLA

Task 2.2 **Field Studies to Test Expanded Slag Utilization**: Under this task, field testing of the applications identified in Phase II, Task 2.1, will begin with test work to optimize the concrete mixes made from expanded slag.

Task 2.3 **Data Analysis of Commercial Utilization of Expanded Slags:** The objective of this task is to assimilate the data and test results collected during Phase II, Task 2.2, convert these findings to common engineering terms, and correlate these results with comparable information for conventional lightweight aggregates as reported in the literature. The data analysis will provide specific answers to the following issues:

- Performance of expanded slag compared with that of conventional materials
- Technical viability of lightweight and ultra-lightweight slags as aggregates.

Task 2.4 **Economic Analysis of Expanded Slag Utilization:** The objective of this task is to expand upon the preliminary economic assessment of expanded slag utilization conducted during Phase I. The economics will be studied based on the production costs for SLA in comparison with current market prices for conventional materials. During the Phase I preliminary evaluation, two production scenarios emerged:

- Production of SLA at the gasifier location (on-site production)
- Production of SLA at a lightweight aggregate facility (off-site production).

The impact of the avoided costs of slag disposal on the economics of SLA production will also be evaluated. Slag utilization data and product samples will be made available to commercial lightweight aggregate users for validation of estimated market prices. The impact of SLA market prices on the economics of SLA production will also be studied.

Task 2.5 **Final Report:** The data generated and collected during the project will be compiled in a final report to be submitted at the end of the project that will be a comprehensive description of the results achieved, consistent with the Reporting Requirements. Data from topical and field reports will be summarized. The report will include the original hypothesis of the project and present the investigative approaches used, complete with problems encountered or departures from the planned methodology, and an assessment of their impact on the project results.

1.5 Scope of This Document

This is the thirteenth quarterly report and summarizes the work undertaken during the performance period between 1 September 1997 and 30 November 1997. This is the sixth quarterly report for Phase II. This document summarizes the Phase II accomplishments to date along with the major accomplishments from Phase I.

2.0 SUMMARY OF WORK DONE DURING THIS REPORTING PERIOD

2.1 Summary of Major Accomplishments

The following was accomplished during the current reporting period:

1. Pilot testing of Slag III to produce expanded lightweight aggregates was completed.

2. Laboratory testing of expanded slag for use in making cement concrete waterproof panels was completed satisfactorily.

3. Exploratory tests using expanded Slag I in nursery applications had mixed results. However, they helped identify the approach to be taken for further testing.

4. Freeze/thaw tests were completed on lightweight concrete specimens made from expanded slag.

2.2 Chronological Listing of Significant Events in This Quarter

The following significant events occurred during the current reporting period:

Date	Description
10/2/97	Exploratory testing of expanded slag for nursery applications completed
10/2/97	Testing of expanded Slag I for block application completed
11/1/97	Testing of expanded slag in panel application completed
11/3/97	Freeze/thaw testing of structural LWA made from SLA completed

3.0 TO DATE ACCOMPLISHMENTS

A summary of the work completed in Phase I is given below.

Date	Phase I Accomplishments Description
10/24/94	Draft Laboratory and Economic Analysis Plan (project work plan) submitted
11/18/94	Slag char removal completed on the advance sample and prepared slag laboratory expansion testing initiated
12/02/94	Final "Laboratory and Economic Analysis Plan" prepared and submitted
05/21/95	Primary slag sample (20 ton) received at Penn State for preparation
06/01/95	Pilot unit for char removal set up and processing work started
08/20/95	Primary slag sample processing for char removal completed
9/10/95	Laboratory expansion studies of slag and slag/clay blends started
10/15/95	1-ft and 3-ft diameter kilns commissioned for pilot testing
11/15/95	Pilot testing of Slag I and Slag II and pellets in 3-ft dia. direct-fired kiln completed
11/17/95	Pilot testing using fluidized bed expander completed
12/12/95	SLA product characterization initiated
1/20/96	Laboratories for testing of SLA products identified
2/16/96	Test plan for second batch of fluid bed expander testing at Fuller completed

A summary of the work completed in Phase II to date is given below.

Date	Phase II Accomplishments Description
4/30/96	Application for continuation of the project to Phase II submitted
5/31/96	Phase I Final Report (draft) submitted to METC
7/1/96	Phase I Topical Report (final version) submitted
7/14/96	Approval for continuation of the project to Phase II was received from METC
7/14/96	Structural concrete laboratory tests started
7/15/96	Lab testing of SLA for roof tile and insulating concrete applications completed
7/15/96	Evaluation of SLA for completed
7/30/96	Evaluation of SLA for loose fill insulation completed
10/10/96	Mix designs for block production selected
11/10/96	Laboratory evaluation of the Slag II completed
10/30/96	Structural concrete laboratory tests completed
11/10/96	Laboratory evaluation of Slag III for LWA production completed
1/10/97	Laboratory testing of SLA for structural concrete application completed
2/19/97	First batch of laboratory tests of selected block mixes completed
4/30/97	Processing of Slag III for char removal completed
5/20/97	Preparatory work for Slag III pyroprocessing completed
7/30/97	Preparation of Slag III for SLA production completed
8/20/97	Utilization of SLA as growing medium for potted plants completed successfully
10/2/97	Exploratory testing of expanded slag for nursery applications completed
10/2/97	Testing of expanded Slag I for block application completed
11/1/97	Testing of expanded slag in panel application completed
11/3/97	Freeze/thaw testing of structural LWA made from SLA completed

4.0 TECHNICAL PROGRESS REPORT

4.1 Manufacture and Testing of Masonry Blocks

Testing of expanded slag in the concrete block application continued from the previous quarter at the facilities of Harvey Cement Products Company, Inc., a major block manufacturer and distributor in the greater Chicago area. Harvey Cement is located close to the recently commissioned Wabash River IGCC plant which is a potential long-term source of slag and hence slag-based LWA. Test mixes were formulated as indicated in Table 1, with the objective of manufacturing two types of blocks:

- Normal-weight blocks with a dry weight of approximately 33.5 lb
- Lightweight blocks with a dry weight of approximately 27 lb.

For both block mixes, conventional lightweight aggregate (marked H) was replaced by two types of slag lightweight aggregates:

- Fine SLA produced from a 10 x 50M slag feed (SLA F)
- Coarse SLA produced from a 1/4" x 10M slag feed (SLA C).

The cement-to-aggregate ratio used was identical to that currently used at the plant. As may be seen in Table 1, for the regular blocks (Mix 30S), the cement-to-aggregate ratio was 1:8.22, and for the lightweight blocks (Mix 19S) it was 1:5.97. However, a third test (Mix 19x1S) was prepared using a slightly higher cement-to-aggregate ratio of 1:5.64, with a lower quantity of the lighter-weight SLA. Water was added on an as-required basis depending on the overall workability of the aggregates and the cement paste in the mix. Test specimens (2" diameter, 3.5" tall cylinders) were made from the concrete and stored in a commercial block-curing chamber. A total of three specimens were made for each batch. The compressive strength was measured after 28 days of curing, and the average values are reported in Table 1.

Table 1. Results of Batch Mix Tests Conducted for Masonry Blocks Using SLA

	Materials Used by Volume, ml						Concrete	
Test Batch	**LS**	**SS**	**SLA F**	**SLA C**	**Total Aggr.**	**Cement**	**Unit Weight lb/ft^3**	**28-day Strength psi**
Unit wt, lb/ft^3	83.8	88.2	44.7	43.9		94.0	-	-
Regular-Weight Block Mix No. 30S (cement-to-aggregate ratio = 1:8.22 by volume)								
Aggregate Mix	55.0	21.0	24 (SLA F or C)		100			
82797-1	1650	630	720	-	3000	346	110.1	1558
82797-2	1650	630	-	720	3000	346	117.9	1791
Lightweight Block Mix 19S (cement-to-aggregate ratio = 1:5.97 by volume)								
Aggregate Mix	43.0		57.0		100			
82797-3	1290	-	1710	-	3000	453	86.5	1402
82797-4	1290	-	-	1710	3000	453	78.6	1090
Lightweight Block Mix No. 19x1S (cement-to-aggregate ratio = 1:5.64 by volume)								
Aggregate Mix	60.0	-	40.0		100			
82797-6	1800	-	1200	0	3000	494	102.2	2180

The regular block mix using SLA F (Test 21997-1) had a 28-day compressive strength of 1558 psi, while one made using SLA C had a strength of 1791 psi (Test 82797-2). The unit weight of the concrete (110-118 lb/ft^3) was considerably lower than the typical value of 150 lb/ft^3 for regular blocks.

Tests with lightweight block Mix 19S resulted in compressive strengths of 1090-1402 psi, which is consistent with the low unit weight of the concrete (78.6-86.5 lb/ft^3).

The next batch of tests (Mix 19x1S) was conducted using a reduced proportion of the SLA(F) (40%) to increase the concrete unit weight and strength. The 28-day strength for this mix (Test 82797-6) was 2180 psi, which is higher than the ASTM requirement of 1400 psi for above-grade blocks and 2000-psi for below-grade load-bearing blocks. The estimated weight of the block if made from Mix 19S was 20.4 lb, and that of the block made from Mix 19x1S was 22.3 lb. Both of these are below the preferred weight of 23 lb for lightweight blocks, which is excellent from the viewpoint of the industry. It is possible to further increase the strength of the SLA concrete by adding some fine sand to compensate for the lack of fines in the slag. This will be considered in the next batch of tests.

4.2 Freeze/Thaw Testing of SLA Concrete

The objective of this test program was to test structural concrete made from SLA for its resistance to repeated freezing and thawing as per ASTM C 666, Procedure B.

The mix designs were the same as previously used to produce sand and SLA-based cement concrete specimens:

- Mix 2211R prepared using 3/4" SLA made from 50/50 slag/clay blend
- Mix 2205R prepared using 5/8" and 3/4" LWA made from clay.

The 28-day compressive strength of the SLA concrete specimen (with 6.0 sacks of cement/yd^3 concrete) was 3000 psi at 114.7 lb/ft^3, which is below the ASTM requirement of 4000 psi at a unit weight of 115 lb/ft^3. However, some specimens using slightly different sand-to-aggregate ratios but the same cement content had compressive strength values of over 4000 psi at unit weights below 115 lb/ft^3.

Table 2 provides the results of the freeze/thaw tests for the two mixes prepared without air entrainment. The results show that the specimen exhibited cracking as a result of freeze/thaw stresses after 64 cycles. At cycle 98, cracking was severe. It is hypothesized that the cracking was due to the following reasons:

- The lower density of the SLA with a higher proportion of pores and higher moisture retention capacity

- The absence of an air entraining agent in the concrete, which typically helps improve freeze/thaw performance.

4.3 Pilot Processing of Slag III for SLA Production

The third slag sample (Slag III) was pyroprocessed in the pilot fluidized bed expander at the Fuller Company R&D facility. The test program focused on the following:

- Testing the feasibility of SLA production over the entire unit weight range between 20 and 55 lb/ft^3 using discrete particles of Slag III (10 x 50M).

- Expanding the granulated material made from a blend consisting of 50/50 Slag III/clay at minus 4 mesh size to produce SLA which meets the requirements for roof tile LWA (50 lb/ft^3).

- Expanding the 4 x 50M fraction of Slag I to produce additional quantities of SLA at a unit weight of <20 lb/ft^3 for the nursery application.

Material Preparation

Char-free Slag III was screened to generate a 10 x 50M fraction for direct firing in the expander. The +10M material was comminuted, mixed with the minus 50M fines, and blended with expansive clay obtained from the Big River Industries LWA plant. The two materials were extruded to make pellets. After air drying, the pellets were granulated at 4 mesh to generate 4 x 20M material, which is suitable for roof tile aggregate.

Table 2. Resistance of Concrete to Rapid Freeze-Thaw (ASTM C 666, Procedure B)

Speci-men		Number of Cycles							
		0	32	64*	98**	0	32	64*	98**
		Mix 2205-R (1)				Mix 2211-R (2)			
1	Relative dynamic modulus of elasticity, %	--	100	76	--	--	***	***	***
	Weight, gm, SSD	5456	5460	5491	--	6063	6072	6098	--
	Weight change, gm	0	+4	+35	--	0	+9	+35	--
2	Relative dynamic modulus of elasticity, %	--	98	67	--	--	***	***	***
	Weight, gm, SSD	5492	5518	5547	--	6053	6069	6119	--
	Weight change, gm	0	+26	+55	--	0	+16	+66	--
3	Relative dynamic modulus of elasticity, %	--	96	64	--	--	***	***	***
	Weight, gm, SSD	5576	5698	5729	--	6043	6060	6100	--
	Weight change, gm	0	+122	+153	--	0	+17	+57	--
Average	Relative dynamic modulus of elasticity, %	--	98	69	--	--	***	***	***
	Weight change, gm	0	+51	+81	--	0	+14	+53	--

(1) Mix 2205R: Control mix using expanded clay LWA at 35.3 lb/ft^3, which made concrete with a compressive strength of 3400 psi and unit weight of 112.8 lb/ft^3.

(2) Mix 2211-R: 505/50 slag clay expanded to 39 lb/ft^3, which made concrete with a unit weight of 114.8 lb/ft^3.

Comments: Test specimens were saturated for a period of four hours at 40°F prior to start of test.

* All specimens exhibited cracking by cycle 64.

** Testing was terminated at cycle 98 due to severe cracking and disintegration.

*** Due to deterioration of specimens, measurements of the fundamental transverse frequency could not be made, precluding calculations of the relative dynamic modulus of elasticity.

The 1/4" x 50M fraction of Slag I was screened to generate a 4 x 50M fraction to produce additional quantities of SLA for the nursery (<20 lb/ft^3) application.

Fluidized Bed Pilot Plant System Description
A six-inch pilot fluidized bed pyroprocessing system which can be operated at a low feed rate of 40-100 lb/hour was used for this test program. This allowed all the necessary data to be generated using the limited quantity of Slag III available. The fluidized bed pyroprocessing system consists of the following:

- Feed hopper and weigh feeder
- Pilot fluidized bed
- Fluidized bed main burner system using natural gas
- Fluidized bed auxiliary burner system injecting fuel oil into the bed
- Combustion oxygen enrichment system
- Cyclone dust collector system
- Baghouse system
- Wet scrubber system
- On-line off-gas analysis system (O_2, CO, SO_2)
- Inlet air oxygen analysis system.

The data acquisition system includes temperature readings at 9 locations and pressure drop across the combustor plenum and the fluidized bed. The feed rate, fuel rate in the main combustor and auxiliary fuel injected into the bed, and oxygen enrichment are set manually and entered in the data acquisition computer. Temperature, pressure, and gas analyses are recorded every minute.

Fluidized Bed System Operation
The system was checked for functionality on 2 December 1997 and started on 3 December 1997. The gas analyzer and feed rate to the fluidized bed were calibrated and the pilot plant was started. The system temperature gradually rose while the grid (lower bed) level fluidization velocity was maintained at 3.5 ft/sec established from cold tube measurements. The feed was started at 20 lb/hour and increased to 50 lb/hour to fill up the fluidized bed. Products discharged from the reactor were collected, weighed, and sampled for unit weight. Cyclone fines were also collected and weighed every 30 minutes.

Figure 1 shows the fluidized bed operating profile for Slag III. As may be seen, the product density was lowered from 60 to 34 lb/ft^3 as a function of the increase in temperature from 750 to 950°C during the operation. However, efforts to further lower the unit weight were not successful as the fluidized bed fused. Consequently, the system was shut down and the bed material was checked and fluidized bed shell lining inspected. The slag deposition on the shell surfaces was removed, and the system was made ready for startup the following day.

On 4 December 1997 the pilot plant was started up using the granulated 50/50 blend of Slag III/clay pellets granulated to 4 x 20 mesh. Due to the clay content of this material, a higher temperature of expansion is required than for slag alone. Figure 2 provides the operating profile for this run. Product samples were collected periodically and measured for their density, which can be controlled as a function of temperature. Sufficient quantities of expanded slag were produced at a unit weight of 50 lb/ft^3 to permit laboratory evaluation, and the plant was then shut down.

On 5 December 1997, the pilot plant was started again using the 4 x 50M fraction of Slag I to produce SLA for the panel application at a unit weight of 40 lb/ft^3 and for the nursery application at a unit weight of <20 lb/ft^3. The operating profile, shown in Figure 3, was identical to runs made previously using this slag.

Figure 1. Fluidized Bed Operating Profile for Slag III Discrete Particles

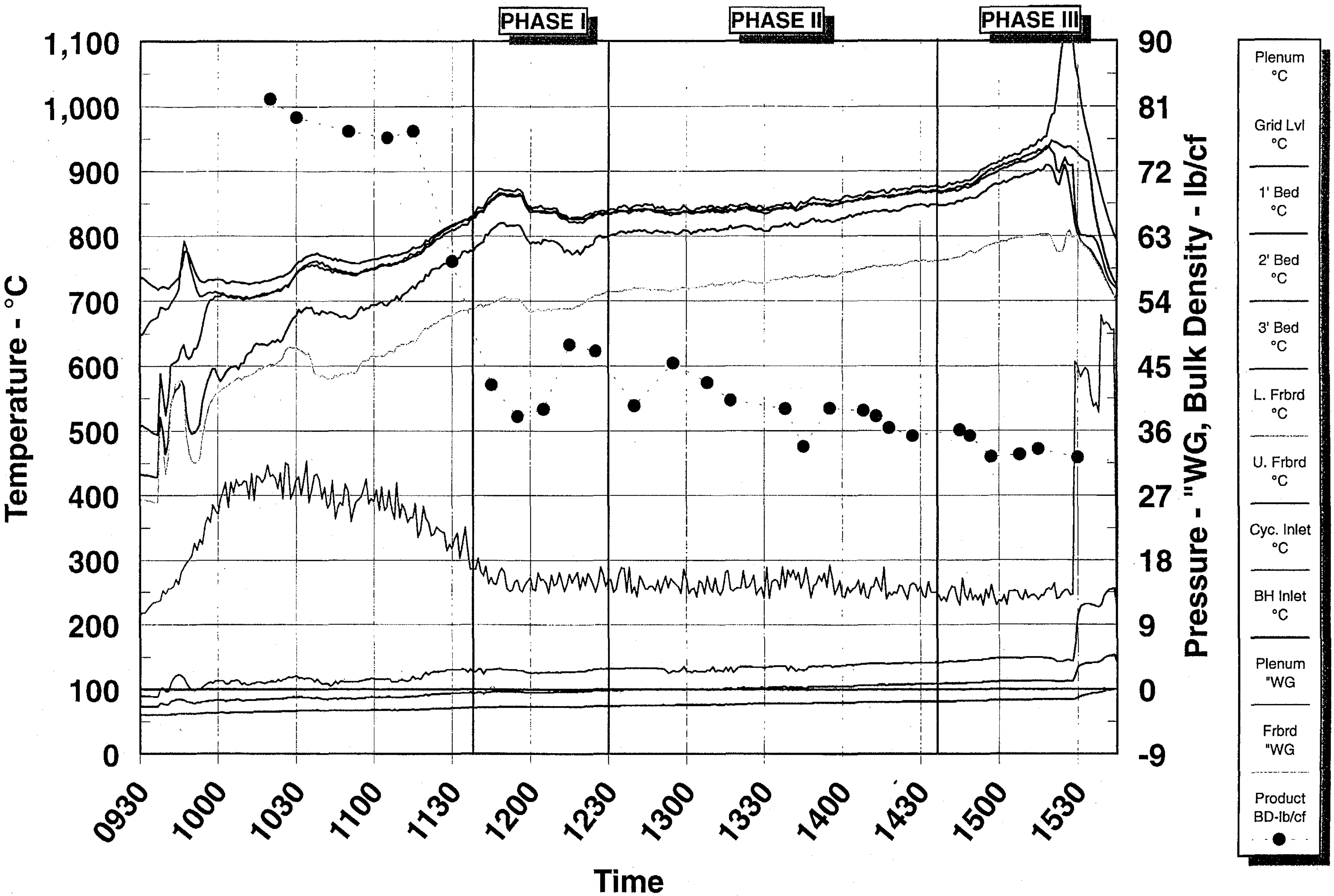


Figure 2. Fluidized Bed Operating Profile for Granulated Material (50/50 Slag III/Clay Blend)

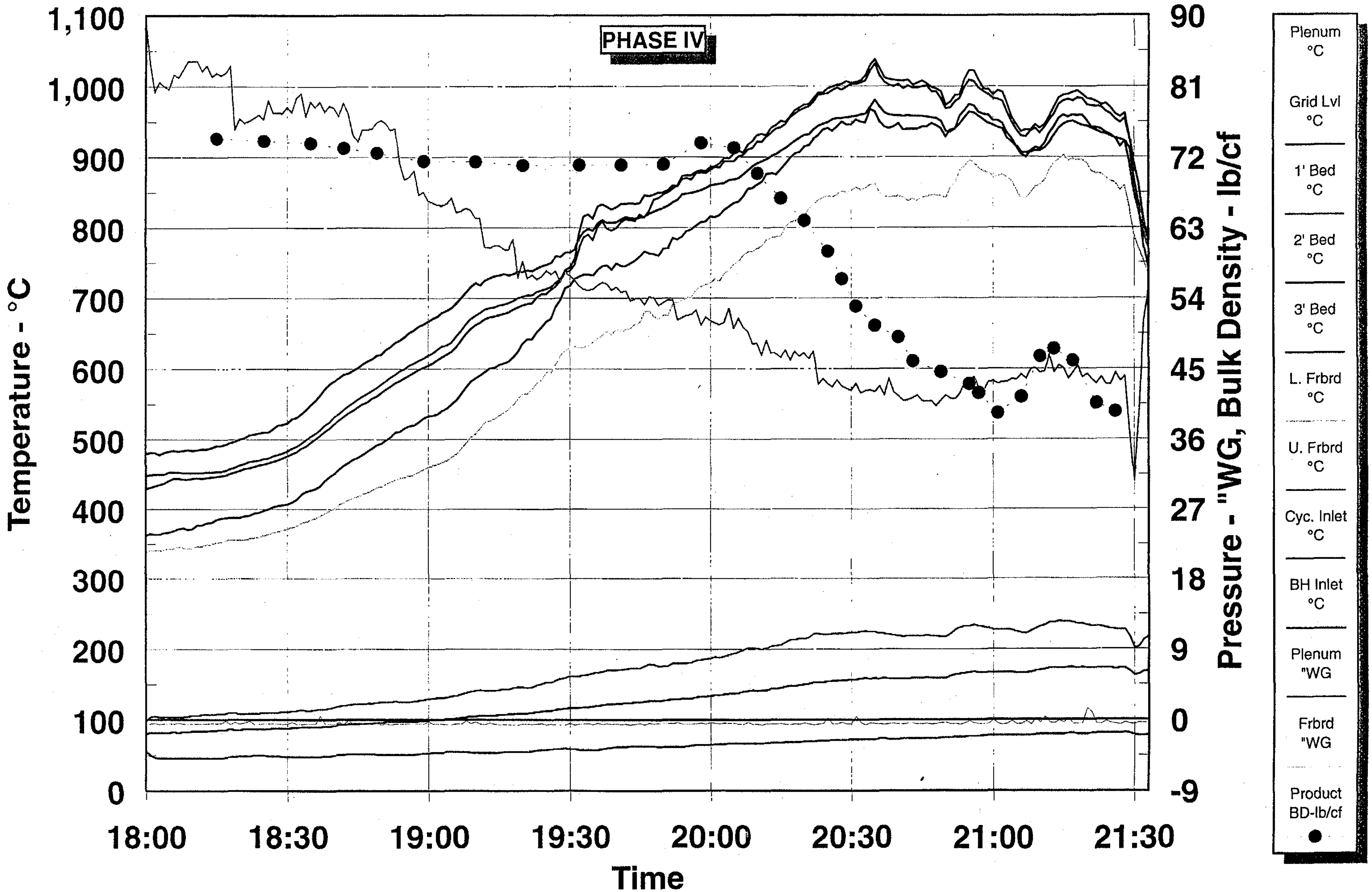
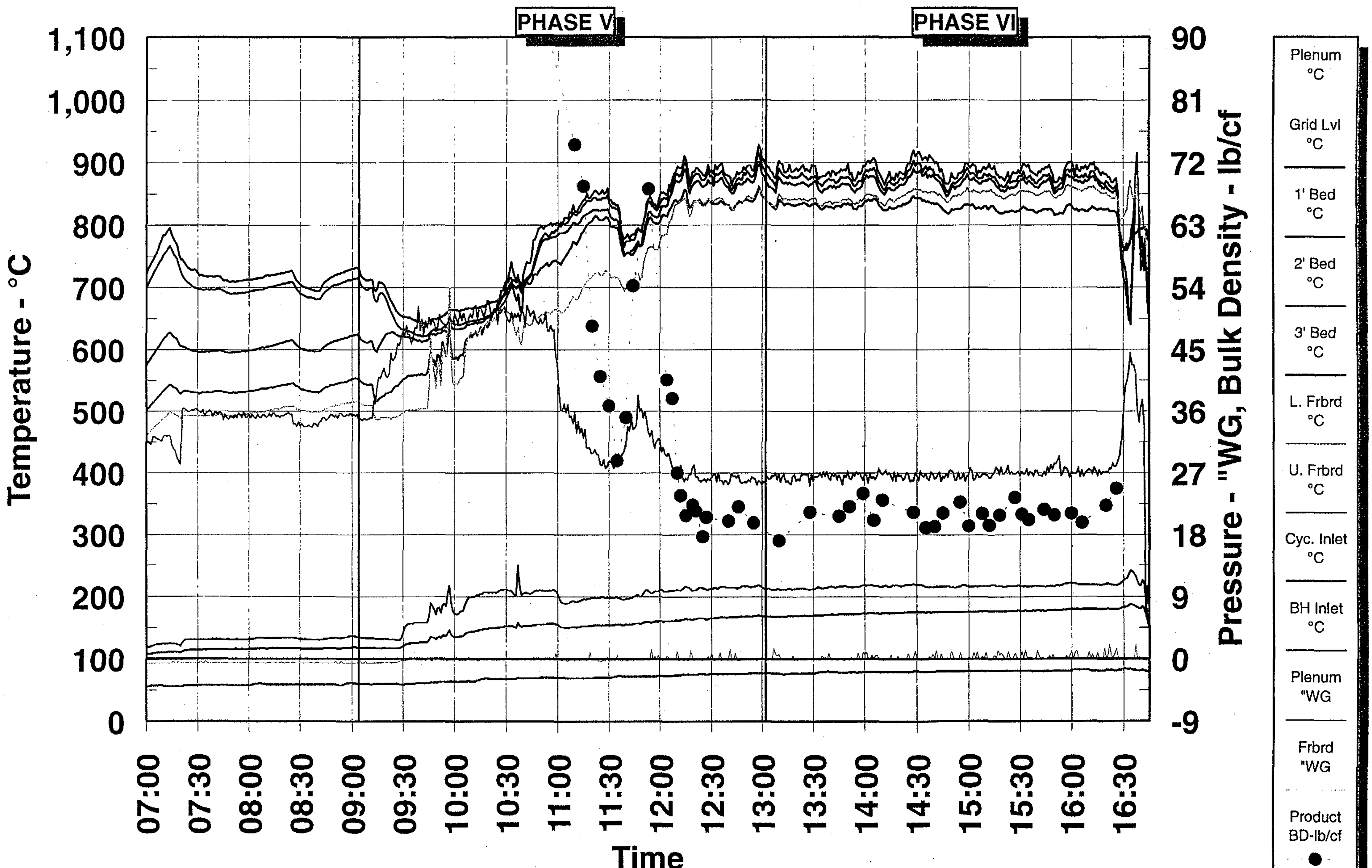


Figure 3. Fluidized Bed Operating Profile for Slag I Discrete Particles



The products are being analyzed for the following:

- Sieve analysis
- Loss on ignition (carbon content)
- Chemical analysis.

The results will be reported in the following quarter.

4.4 Laboratory Evaluation of SLA in Nursery Applications

Expanded slag was evaluated for its properties in nursery applications, where it was compared with perlite, vermiculite, and a typical soil mix. This test work was done at the Evergreen Nursery located in Tennessee, which was selected based on their expertise in this field, the unique techniques they employ to control the supply of nutrients, and their willingness to test a new material.

Three samples of SLA I were used for this test work, along with a standard perlite mix and a soil mix. The topsize and unit weight of the SLA samples used for this work is given below:

- Sample A: 1/4" topsize and unit weight of 35-40 lb/ft^3
- Sample B: 1/4" topsize and unit weight of 20-30 lb/ft^3
- Sample C: 1/4" topsize and unit weight of 20 lb/ft^3
- Perlite/vermiculite mix
- Typical soil mix

The evaluation consisted of observation of the growth rate, general health, and appearance of tomato plants grown in a solarium.

As may be seen in Table 3, the initial weight of the three slag samples (6.75-10.5 lb) used to fill the flats was considerably higher than that of the other materials. Also, the maximum moisture content under full saturated conditions (19-29%) was considerably lower than that of the other materials. The customary frequency of watering and fertilizer addition was followed. This approach allowed comparison of water and fertilizer retention capacity. Plant growth was measured over a period of 20 days between 8 July 1997 and 28 July 1997, and the general condition of the plants reported. For the three samples, the best results were obtained for Sample B, where only one plant wilted during the entire period. In the case of Sample A, five plants wilted, while for Sample C, seven plants wilted. This trend does not seem to follow the moisture retention capability of the three samples of expanded slag. While the reason for this is not fully understood at this time, the data indicate that SLA may be used as a partial substitute for conventional nursery materials.

Table 3. Evaluation of Expanded Slag in Supporting Plant Growth

	Sample A	Sample B	Sample C	Vermiculite	Perlite	Soil Mix
Unit wt, lb/ft^3	35-40	20-30	<20	-	-	-
Dry wt, lb	10.5	9.5	6.75	4.25	4.0	5.5
Wet wt, lb	13.0	12.25	9.5	13.0	9.25	11.5
Water retention, lb	2.5	2.75	2.75	8.75	5.25	6.0
Max. moisture content, wt%	19	22	29	67	57	52
Water retention, lb/100 lb	24	29	41	206	131	109
7/8/97	Planted and watered all flats					
7/14/97	Fertilized all flats with CalMag 15-5-15					
7/15/97	Measured height and condition of plants					
Height, inches	1	1¼	1¼	1¾	1½	1¾
No. of plants that died*	5	0	4	0	0	0
7/16/97	Fertilized (20-10-20) vermiculite, perlite, and soil mix flats					
7/21/97, height (inches)	1½	1¾	1¾	3¾	2¾	3¾
No. of plants that died*	5	0	4	0	0	0
7/22/97	Fertilized all flats with 20-10-20					
7/28/97, height (inches)	3	2¾	2½	7	7	8
No. of plants that died*	5	1	7	0	0	0

* Out of 18 plants per flat.

The following conclusions were drawn from these tests:

- Slag can be used as a partial substitute for conventional potting materials.
- The moisture retention capacity of the slag needs to be improved by opening up the pores. This may be accomplished by crushing the expanded slag and using a finer slag particle size.
- The low moisture retention capacity of the SLA can be accommodated provided that it is used along with materials that have a higher moisture retention capacity.
- The higher unit weight of the slag can add stability to larger shrubs, specifically those in containers over 3 gallons in capacity. This stability is currently achieved using bark chips.
- SLA has an excellent aeration capacity.

4.5 Evaluation of SLA in Production of Cement Panels (Waterproof Boards)

Based on evaluation of the results on the use of SLA in insulating concrete, another similar application was identified: production of lightweight cement concrete panels used in the construction of bathrooms and other areas where the walls are exposed to moisture. This is a relatively new but fast growing application that requires 35-45 lb/ft^3 aggregates. Praxis contacted a manufacturer and sent samples of SLA to them for laboratory evaluation. A batch of SLA I was sent to the manufacturer and exploratory tests indicated that SLA could be used as an aggregate to make these panels. Additional specimens are being prepared to determine the most suitable aggregate unit weight and particle size.

5.0 PLAN FOR THE NEXT QUARTER

The following activities are planned for the next quarter:

- Continue laboratory evaluation of SLA I for horticultural, structural concrete, and panel applications.
- Conduct laboratory testing and select a mix design for the commercial-scale block-making production run.
- Complete laboratory evaluation of the SLA for concrete panel applications.
- Initiate laboratory characterization testing of SLA III (sieve analysis, loss on ignition, and chemical analysis).